Hell J Surg. 2025 Apr-Jun;95(2):92–95
doi: 10.59869/doi: 10.59869/25066

Fluorescence-guided laparoscopic adrenalectomy: A step-by-step technique

Panagiotis Metaxas, Konstantinos Polyzois, Vasiliki Stamatoukou, Despoina Iordanidi, Eleni Rakka, Fotios Seretis, Michail Psarologos, Maria Sotiropoulou, Vasileios Drakopoulos, Stylianos Kapiris

Third Department of Surgery, Evangelismos Athens General Hospital, Athens, Greece

ABSTRACT

Indocyanine green (ICG) fluorescence is emerging as a valuable aid during laparoscopic adrenalectomy (LA), providing intraoperative assistance in the identification of the adrenal vein and the delineation of adrenal anatomy and tumour margins. Herein, we describe our standardised technique of injecting ICG at two different stages of LA, including patient selection and stepwise execution. We also share our experience, having performed over 67 ICG fluorescence-guided LAs, along with practical tips for overcoming initial technical difficulties. We believe that ICG in LA may play a role in the teaching process of junior surgeons, in challenging cases of LA as an assisting adjunct, and in selected cases of cortical-sparing LA.

Key Words: *Laparoscopic adrenalectomy; ICG imaging; fluorescence-guided laparoscopy; cortical-sparing adrenalectomy; minimally invasive adrenalectomy*

INTRODUCTION

Laparoscopic adrenalectomy (LA) has become the standard of care for most benign adrenal lesions since its first description in 1992 [1]. Although the procedure is well-established, the conditions requiring treatment by LA are rare, making it difficult for many young surgeons to gain sufficient operative experience. Fluorescence-guided laparoscopy with the use of indocyanine green (ICG) has emerged as valuable a tool to enhance a surgeon's ability to discern between different types of tissues during minimally invasive surgery [2]. The fluorescent properties of ICG can be utilised during LA, to visualise the margins of the adrenal gland, identify the adrenal vein and even delineate the tumour borders from the normal adrenal gland [3].This article provides our accumulated experience from 67 cases of fluorescence-guided LAs, with a step-by-step description of the technique, along with useful tips and tricks to facilitate adoption of this technique.

Corresponding author:
Panagiotis Metaxas
Address: 31 Arktinou St., Athens, Greece, 11635
Tel.: +30 6947 188 762
e-mail: p.metaxas@yahoo.com
Orcid ID: 0000-0002-5539-783X

Submission: 07.12.2025, Acceptance: 22.05.2026

Rationale for the use of ICG in adrenal surgery

The most challenging and time-consuming step of an LA is the identification of the adrenal vein. It is therefore logical that an intraoperative fluorescent angiographywith the use of ICG, which will improve a surgeon's ability to safely and quickly identify the adrenal vein, is a valuable tool. In addition, ICG, when injected intravenously, binds to plasma proteins and therefore its concentration and fluorescence are proportional to a specific organ's blood supply. When taking under consideration that adrenal glands possess the third highest blood flow in the abdomen, early adopters of the technique hypothesised that ICG will prove valuable in adrenal surgery, as most anatomical

landmarks of the procedure can be easily distinguished from their surrounding tissue.

Patient selection and perioperative considerations

After a thorough review of the literature, a protocol was created, in which all patients undergoing LA were considered eligible for ICG administration. ICG has no known metabolites according to the literature, so no adverse effects have been reported [4]. A contraindication to ICG administration is allergy to iodine-containing agents, so it was decided that such patients were to be excluded from the protocol.

SURGICAL TECHNIQUE

Operating room setup and patient positioning

The right equipment is of paramount importance for the completion of this procedure, as a laparoscopic tower with fluorescence imaging capabilities and an infrared (IR) camera are needed. We use a VISERA ELITE II 3D Imaging System (Olympus Medical System Corp., Tokyo, Japan) with an Olympus laparoscopic tower (Olympus Medical System Corp., Tokyo, Japan). The equipment is calibrated, and we make sure that we can switch from the conventional laparoscopic view to ICG imaging by pressing one button on the laparoscopic tower. Successful integration of fluorescence imaging requires close coordination with the anaesthesiology team, so the ICG dye, diluted in water for injection, is prepared prior to the operationand placed near the anesthesiology table and clear instructions are given to the anesthesiologists about ICG injection prior to the procedure. A lateral decubitus position, with the table flexed to around 30° is selected for the operation, as this position enhances the accessibility of the surgical field. In left adrenalectomies three trocars are used, whereas in right adrenalectomies a fourth trocar is needed, to retract the liver (Figure 1). An IR camera, capable of activating and capturing ICG's fluorescent capabilities, is used from the beginning of the operation, to minimize the additional time of the fluorescence imaging component of the operation.

Initial stages

Since right and left LA are two different operations, we will describe the initial steps in each procedure, immediately before the first dose of ICG, to clarify the purpose of ICG administration.

In right LA, the assisting surgeon retracts the liver and the operating surgeon divides the liver's retroperitoneal attachments. The right liver lobe is mobilised laterally to achieve good high subhepatic access in the lateral region.

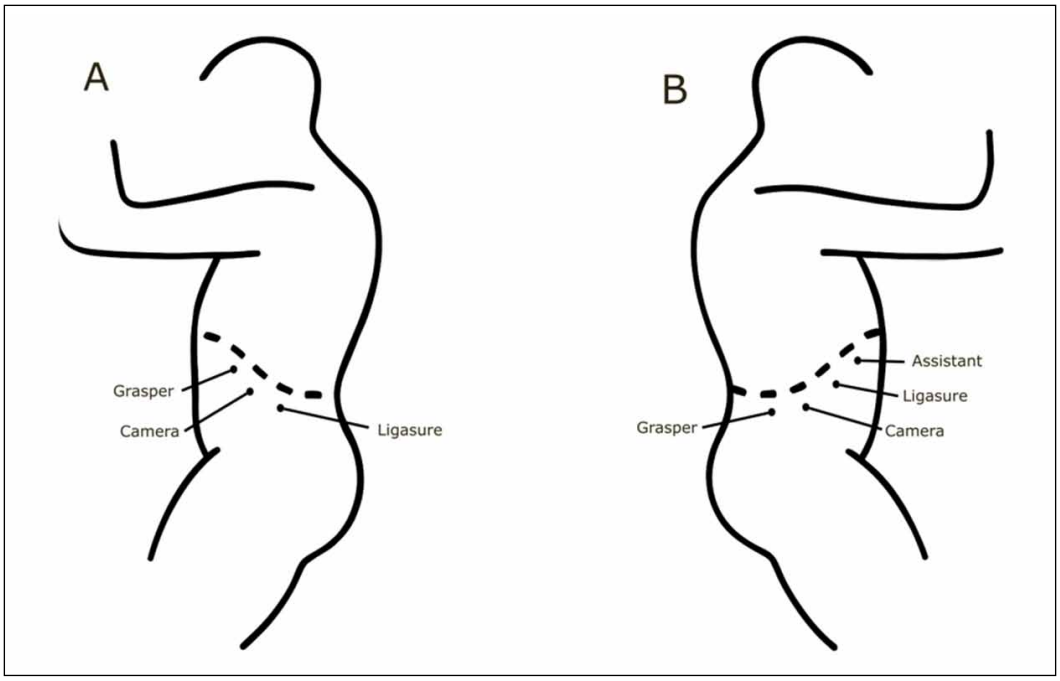

FIGURE 1 A) Trocar placement in left laparoscopic adrenalectomy. A 12 mm camera port in the subcostal area and two 5–10 mm working ports (the midclavicular and anterior axillary lines)were placed. B) Trocar placement in right laparoscopic adrenalectomy. A 12 mm camera port in the subcostal area and two 5–10 mm working ports (the subcostal region near the mid-clavicular line and the posterior axillary line) were placed along with a fourth trocar (at the right of the umbilicus) to retract the liver.

With the adrenal gland being gently pushed caudally with a grasper holding a gauze, we divide the retroperitoneum along the edge of the liver. After identifying the anatomic plane of the adrenal gland and before any further dissection of the gland or any vascular manipulation is performed, the first dose of ICG is administered, as will be described later. The adrenal gland is further dissected, and the adrenal vein is identified. In our series, ICG imaging delineated the course of the adrenal vein prior to visual identification in most cases. The next step is the careful dissection of the adrenal vein. This is the time frame for the administration of the second ICG dose. Then, the adrenal vein is ligated and divided with electrocautery. This is the most crucial step of the procedure, as the adrenal vein drains, after a very short distance, directly into the inferior vena cava. The final steps include the complete dissection of the adrenal gland, which is placed in an endobag and extracted from the abdomen.

In left LA, the splenic flexure of the descending colon is mobilised and retracted medially. The ligaments of the spleen are divided and both the spleen and the pancreas are mobilised anteriorly and retracted medially, until we reach the anatomic plane of the left kidney and adrenal gland. Again, the first dose of ICG is injected before any further dissection of the adrenal gland or vascular manipulation occurs. The adrenal gland is identified and further dissected, while the adrenal vein is visualised in most cases by fluorescence imaging in this study, before visual confirmation. The procedure continues as described for right LA.

ICG preparation and administration

In accordance with the published literature, we reconstitute the ICG by adding 10 cc of sterile water for injection (WFI) to a vial containing 25 mg of ICG, providing a final concentration of 2.5 mg/cc. ICG is administered in two doses at different time points during the surgery, with each serving completely different purposes.

The first dose is administered immediately upon identifying the adrenal gland, intentionally preceding visual identification of the adrenal vein. The aim of this first fluorescence imaging is to quickly and accurately distinguish the adrenal vasculature, as well as the margins of the adrenal gland. This technique can prove particularly useful, reducing operating time and increasing the safety of the operation, as it facilitates timely identification of the principal anatomical landmarks required to safely complete the operation.

The second dose is administered after the adrenal gland and the adrenal vein have been further dissected. The purpose of this is to identify the adrenal tumour, as most of the times the tumour exhibits different fluorescence intensity compared with the normal adrenal gland. If this is the case, the margins of the tumour are delineated, which can serve as the leading point of excision when cortical-sparing adrenalectomy is the choice of operation. In addition, in complicated cases involving huge adrenal tumours, adrenal fluorescence clearly defines its margins and improves the surgeon's ability to perform the operation safely.

DISCUSSION

Right and left LA are two different procedures; therefore, it is only natural to expect different results when ICG imaging is involved. The most profound difference is the presence of the liver, as it exhibits higher fluorescent intensity than its surrounding tissues, adrenal included, so it poses a challenge in the early stages of the ICG experience. We believe that this challenge is overcome with experience. In our study, we recorded each procedure individually, and after every 10 right-sided LAs we performed a structured review to enhance our familiarity with the technique and analyse our observations.

Another important note is that the administration of ICG and the fluorescence imaging do not prolong the procedure, if adequate preparations have taken place preoperatively and there is some experience with the technique. On the contrary, the use of ICG enhanced our ability to quickly identify the adrenal vein, in most of the cases, especially in left-sided LAs, which, in our experience, can lead to decreased operating times. This remains an observation of our team through experience, as it was not an endpoint of our study, and further research is required to confirm this.

Our surgical department places strong emphasis on surgical education and training. Fluorescence-guided laparoscopic adrenalectomy represents a valuable educational tool, particularly for trainees. It facilitates the most technically demanding step of the procedure, the identification of the adrenal vein, thereby enhancing visual guidance. Indocyanine green (ICG) fluorescence allows precise localisation of the vein, enabling safe and effective ligation. Furthermore, the use of ICG supports surgical training by providing a reproducible and standardised approach, thereby enhancing teaching within the department.

The optimal use of ICG imaging in LAs has not yet been established. However, there is a strong focus in the literature on cortical-sparing adrenalectomy. The study by Kahramangil et al., including 100 patients which

is the largest number up to date, reports that 67% of pheochromocytomas appear "hypofluorescent" compared to its surrounding tissues, which means that they exhibit lower fluorescent intensity than them. It is suggested that in 2 cortical-sparing robotic adrenalectomies performed, the technique proved to be useful, as it enhanced the surgeon's ability to delineate the tumour margin, as the adrenal gland was more fluorescent than the pheochromocytoma [5]. This is also suggested by the study of Lerchenbergeret al., involving three partial adrenalectomies, where the modality was useful in the two pheochromocytomas included [6].

Our findings are consistent with the existing literature, as pheochromocytomas in our series also demonstrated relative hypofluorescence compared to the surrounding adrenal cortex. Similar observations have been reported previously, including in our prior study [7], further supporting the reproducibility of this fluorescence pattern.

CONCLUSION

In this study, we presented a novel technique, fluorescence-guided LA. We found that the technique has a relatively short learning curve and is easily reproducible. We believe that even though ICG imaging during LAs should not yet be considered a routine technique, as its optimal use is not yet defined, surgeons should become familiar with it, as it can prove useful in complex cases and in cortical-sparing laparoscopic adrenalectomy.

Source of funding: *None*

Conflict of interest: *Nothing to declare*

REFERENCES

1. Gagner M, Lacroix A, Bolté E. Laparoscopic adrenalectomy in Cushing's syndrome and pheochromocytoma. N Engl J Med. 1992 Oct;327(14):1033.
2. Boni L, David G, Mangano A, Dionigi G, Rausei S, Spampatti S, et al. Clinical applications of indocyanine green (ICG) enhanced fluorescence in laparoscopic surgery. Surg Endosc. 2015 Jul;29(7):2046-55.
3. Colvin J, Zaidi N, Berber E. The utility of indocyanine green fluorescence imaging during robotic adrenalectomy. J Surg Oncol. 2016 Aug;114(2):153-6.
4. Arora E, Bhandarwar A, Wagh A, Gandhi S, Patel C, Gupta S, et al. Role of indo-cyanine green (ICG) fluorescence in laparoscopic adrenalectomy: A retrospective review of 55 Cases. Surg Endosc. 2018 Nov;32(11):4649-57.
5. Kahramangil B, Kose E, Berber E. Characterization of fluorescence patterns exhibited by different adrenal tumors: Determining the indications for indocyanine green use in adrenalectomy. Surgery. 2018 Nov;164(5):972-7.
6. Lerchenberger M, Gündogar U, Al Arabi N, Gallwas JKS, Stepp H, Hallfeldt KKJ, et al. Indocyanine green fluorescence imaging during partial adrenalectomy. 2020 May;34(5):2050-5.
7. Metaxas P, Dafnios N, Konstantoulakis M, Nastos C, Mavrodimitraki E, Polyzoes C, et al. Indocyanine green (ICG) fluorescence in laparoscopic adrenalectomy: Categorization of adrenal tumors relative to normal adrenal gland. Updates Surg. 2026 Feb;78(1):397-403.